Adult and Juvenile Coho Salmon Enumeration and Coded-wire Tag Recovery Analysis for Zolzap Creek, BC, 2003

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ADULT AND JUVENILE COHO SALMON ENUMERATION AND CODED-WIRE TAG RECOVERY ANALYSIS FOR ZOLZAP CREEK, BC, 2003

prepared by

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ABSTRACT

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Adult and juvenile coho migrations were monitored at Zolzap Creek, British Columbia, as part of the 2003-2004 Nisga'a Fisheries Program. The 2003 season is the twelfth year of continuous operation of the Zolzap Creek fences since 1992. This report includes twelve-year summaries of the most pertinent data. Smolt trapping was conducted from 30 April to 6 June 2003 using an in-stream wire-mesh fence. A total of 30,005 coho smolts were captured during the trapping period, and an unknown number migrated out during periods when the fence was not operational. Of those captured, 26,305 were released with coded-wire tags. Migration timing, mean length and weight at age, and age composition are presented.

Adult coho escapement was monitored using an in-stream fence and carcass surveys. The counting fence was operational between 24 August and 25 October. A total of 1,444 adult coho were counted at the fence with an estimated escapement of 2,855 (95% CL: 2,476 to 3,292) using the adjusted Peterson model. Adipose clip rate was 30.5% for adult coho. Age and length characteristics of adult males and females are presented.

Canadian and US commercial harvests were examined using coded-wire tag recovery data obtained from the Mark-Recovery Program and the Alaska Department of Fish and Game (ADF&G) mark tag and age lab online searchable database. Total exploitation rate on Zolzap Creek coho in 2003 was 40.1% (6.1% Canadian, 34.0% US). Of the total commercial catch of Zolzap Creek coho, Canadian catch accounted for 15.1% and the US catch accounted for an estimated 84.9%. Harvests occurred over a wide area ranging from SE. Alaska to the US Northern Outside Statistical Area in Alaska (northwest of Juneau, AK). Limited Canadian commercial harvests occurred in Areas 1-5 for Zolzap Creek in 2003. US harvests of Zolzap coho in Alaska were largest in the Southern Inside Statistical Area for the net fishery and the Central Outside Statistical Area for the troll fishery. Total survival was 11.8% and smolt-to-spawner survival was 7.0%.

RÉSUMÉ

Baxter, B.E. and C. Y. Stephens. 2004. Adult and juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 2003. Can. Manusc. Rep. Fish. Aquat. Sci. 2703: viii + 47 p.

Les migrations de saumons coho, adultes et jeunes, ont été mesurées au ruisseau Zolzap en Colombie-Britannique, dans le cadre de la Stratégie des pêcheries autochtones des Nisga'a en 2003-2004. L'année 2003 marque la 12ième saison d'opération continue des barrières en fil métallique du ruisseau Zolzap depuis 1992. Ce rapport contient 12 ans de sommaires des données les plus intéressantes. Le piégeage des saumoneaux prit place entre le 30 avril et le 6 juin 2003 à l'aide d'une barrière en fil métallique installée dans le ruisseau. En tout, 30,005 saumoneaux coho ont été capturés pendant la période de piégeage tandis qu'un nombre inconnu a migré quand la barrière n'était pas opérationelle. Sur l'ensemble des saumoneaux capturés, 26,305 ont été remis à l'eau avec une marque magnétique codée. La période de migration, la longueur moyenne, le poids et la composition selon l'âge sont présentées.

L'échappée de saumons coho adultes a été surveillée grâce à une barrière installée dans le ruisseau et à l'observation des carcasses. La barrière de comptage fut opérationelle entre le 24 août et le 25 Octobre. Un total de 1,444 saumons coho adultes ont été dénombrés à la barrière avec une échappée estimée à 2,855 (95%CL : 2,476 à 3,292) utilisant le model Peterson ajusté. Le taux d'ablation de la nageoire adipeuse était de 30.5% pour les saumons coho adultes. Nous présentons les caractéristiques d'âge et de longueur pour les mâles et les femelles adultes.

Les récoltes commerciales canadiennes et américaines ont été examinées grâce aux données de récupération des marques magnétiques codées provenant du Programme de marquage-récupération et en direct de la base de données du Département de Pêche et Chasse de l'Alaska. En 2003 le taux total d'exploitation commerciale de saumon coho au ruisseau Zolzap fut évalué à 40.1% (6.1% pour le Canada, 34.0% pour les États-Unis). Sur le total de prises commerciales de saumon coho au ruisseau Zolzap, le Canada en comptait 15.1% et les États-Unis, une estimation de 84.9%. Les récoltes couvraient un vaste secteur, s'étendant à partir du sud-est de l'Alaska jusqu'à la zone statistique nord extérieure de l'Alaska aux États-Unis (au nord-ouest de Juneau, AK). Des récoltes commerciales Canadiennes limitées ont prit place dans le secteur 1-5 pour le ruisseau Zolzap en 2003. Les saumons coho du Zolzap récoltés par les États-Unis en Alaska furent plus nombreux dans la zone statistique sud intérieure pour la pêche au filet, et, dans la zone statistique centrale extérieure pour la pêche à la traîne. Le taux total de survie fut 11.8% tandis que pour les saumoneaux/géniteurs le taux de survie fut 7.0%.

INTRODUCTION

As part of the Aboriginal Fisheries Strategy (AFS), a program was established for fisheries research in the Nisga'a Traditional Territory, British Columbia. One component of this large research initiative focused on the assessment of juvenile and adult coho populations in tributaries to the Nass River. Juvenile and adult coho enumeration studies have been conducted on Zolzap Creek since 1992 (Nass 1996a; Nass 1996b; Nass 1996c; Nass and English 1994; Nass 1997a; Nass 1997b; Nass 2001; Nass and Frith 2001; Baxter et al. 2001; Baxter and Stephens 2002, Baxter and Stephens 2002a, Baxter and Stephens 2002b, Baxter 2003). This report presents results for studies conducted at Zolzap Creek in 2003.

The objectives of the research were to:

1. Enumerate migrating juvenile coho and estimate escapement;
2. Document the timing, size, and age distribution of migrating coho;
3. Mark coho smolts with coded-wire tags (CWT) to enable the determination of oceanic harvest rates;
4. Monitor the escapement for marked CWT adult coho, and determine ocean exploitation and survival rates; and
5. Collect water temperature and level data for future examination of the relationships between physical environmental factors and coho smolt migration timing, and between adult escapement and smolt production.

Achievement of these objectives involved the construction and operation of in-stream, semi-permanent, panel fences located approximately 0.5 km upstream of the mouth of Zolzap Creek.

STUDY STREAM

Zolzap Creek is a tributary to the Nass River, located in northwestern British Columbia (Figures 1 and 2). Zolzap Creek flows for 6 km in a northwesterly direction between Nisga'a Lava Bed Memorial Park and the Kitimat Mountain Range to its confluence with the Nass River, 5 km downstream of Gitwinksihlkw. The main channel of the creek is regularly interrupted by beaver dams and log jams. The substrate is highly variable and ranges between silty particulate, granite cobble, and coarse pumice. Major flow contributions come from Lava Creek (3 km in length) which flows from the lava beds and numerous small creeks that flow from the steep alpine. Intermittent flows of water from the Nass River and Vedder Creek are possible during flooding periods. The mouth of Zolzap Creek enters a side channel to the Nass River known as Zolzap Slough. The lower 0.5 km of Zolzap Creek regularly becomes inundated when water levels on the Nass River are high. Zolzap Creek supports many species of salmonids including coho (*Oncorhynchus kisutch*), pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), rainbow

(*O. mykiss*), cutthroat (*O. clarki*), and Dolly Varden (*Salvelinus malma*). Non-coho species include lampreys (family Petromyzontidae), sticklebacks (family Gasterosteidae), and sculpins (family Cottidae). Coho escapement was estimated to be 1,561 in 1992 (Nass 1996b), 1,048 in 1993 (Nass 1996c), 2,536 in 1994 (Nass 1997a), 908 in 1995 (Nass 1997b), 1,039 in 1996 (Nass 2001), 470 in 1997 (Nass and Frith 2001), 967 in 1998 (Baxter et al. 2001), 1,393 in 1999 (Baxter and Stephens 2002), 456 in 2000 (Baxter and Stephens 2002a), 1,897 in 2001 (Baxter and Stephens 2002b), and 3,233 in 2002 (Baxter 2003).

JUVENILE COHO STUDIES

METHODS

Trapping Operations

An in-stream, semi-permanent enumeration fence was located 0.5 km upstream of the creek mouth for the capture of downstream migrating coho smolts. Fence design was based on Conlin and Tutty (1979) and minor modifications were required due to site characteristics and available materials. The fence was built in a W-pattern and spanned the entire creek bed. Three-by-eight-foot panels constructed of 2x4's and covered with 1/4" wire-mesh were laid on their long side in the creek bed to form the fence. Rebar of 3/8" and 1/2" diameter were used to anchor the panels to the stream bed. A second layer of panels were installed on top of the first row of panels to create a fence with a total height of six feet. Burlap sandbags and heavy duty plastic garden sheeting were used to seal the base of the panels. Two hinged panels were installed in each of the fence wings for release of excess water in the event of flooding. Plywood trap boxes with Vexar-screened windows (to allow water exchange) were anchored at each down-stream apex and were connected to the fence with 8" Big-O tubing. Additional boxes were made for holding fish after processing and were designed with a small door for releasing fish. Provisions for upstream migrating adults were made by constructing a simple trap consisting of a wire-mesh panel extending out from the stream bank to one wing of the fence. Plywood was used to cover the adult trap area.

Physical Observations

Crews monitored water temperatures, water levels, and weather daily. Crews recorded temperature to the nearest degree (1 ^{o}C) using a maximum-minimum thermometer and water level using staff gauges calibrated to the nearest centimeter (0.01 m). A total of three staff gauges were used; two were located within 50 m of the trapping site (one upstream, one downstream of the fence) and one approximately 1 km upstream of the fence. Precipitation was recorded on a scale of zero to five with zero representing no precipitation and five being heavy precipitation.

Fish Enumerations

Daily numbers of coho smolts captured at the fence were obtained from automatic counters on coded-wire tagging machines or by manual counts. The number of fence mortalities

was added to the total count. Coho juveniles with standard lengths greater than or equal to 70 mm were identified as smolts. Coho smaller than 70 mm tended to be dark with distinct parr marks and lacked the silver colouration typical of smolts. Therefore, this group consisted of pre-smolts and fry. All coho pre-smolts and fry, and non-coho species were counted and released downstream of the fence during sorting. Upstream migrating juveniles caught in the adult traps were counted and released upstream.

Biosampling

A random sample of up to 25 smolts (i.e., coho greater than or equal to 70 mm) was obtained from each day's catch. These smolts were anaesthetized and measured for fork length and weighed using an electronic scale (0.1 g). Scale sampling followed the stratified method of Ketchen, described by Ricker (1975); age sample data (column X on Table 1) included non-random samples, and length sample data (column Y on Table 1) and the calculated age representation was based on random sampling. Crews attempted to collect at least 10 scale samples from each 5 mm size class of coho for the study period. Smolts from under-represented size classes were selected to supplement random samples. Mean length and weight data was determined by multiplying the mean length and weight data for each 5 mm bin class by the total number of length and weight samples in that bin class (factor) to come up with a weighted mean length and weight for that bin class. The average length and weight for all sampled fish was determined by summing all the weighted length and weight measurements and dividing by the overall sum of the factors. Scale samples were interpreted by the Fisheries and Oceans Canada Scale Lab, Nanaimo, BC. Secondary quality control checks were performed to ensure a reliable age designation. Scale ages are reported in Gilbert-Rich notation where freshwater age-2 coho (i.e., having survived two winters from egg deposition) have a single freshwater annulus.

Coded-wire Tagging

Coded-wire tagging at Zolzap Creek was performed using a Mark IV tagging machine (Northwest Marine Technology Ltd. Shaw Island, WA). Smolts were anaesthetized in a MS222 bath prior to tagging. All tagged fish were adipose fin-clipped (AFC). The numbers of coho smolts tagged with each tag code and the number of smolts untagged were recorded. All tagged smolts were placed in a holding box in the stream and allowed to recover from the tagging operation before release.

Tag retention tests were conducted for each tag code. A sample of tagged coho smolts (minimum of 200 smolts) were retained in a holding box from 24 h to 72 h. Following the holding period, smolts were lightly anaesthetized and checked for the presence of a coded-wire tag using the quality control device (QCD) from the coded-wire tagging machine. Coho smolts not possessing a tag were checked a second time. The total number of tags detected for each tag group and the total number of fish tested was recorded.

RESULTS

Physical Observations

Water temperatures during the smolt migration period at Zolzap Creek ranged from a minimum of 8 °C in early May to a maximum of 10 °C in early June (Table A-1, Figure 3A). Water level at gauge 2 (50 m upstream of the fence) remained steady at a gauge height of approximately 0.3 m from the beginning of monitoring on 30 April until 23 May. Water level rose steadily to a level of 0.4 m on 24 May and then rose rapidly to a level of 1.3 m on 25 May (Table A-1, Figure 3A). Water levels subsided rapidly and fluctuated from 0.4 to 0.9 m for the duration of the spring monitoring period. High water levels in Zolzap Creek occur when the Nass mainstem flow rises causing water to back-up into the creek. Water flow in Zolzap Creek declines to very low velocities during these flooding events.

Fish Enumerations

The Zolzap Creek juvenile counting fence was operated from 30 April to 6 June 2003. Approximately 25 to 30 baited gee traps were used to supplement catches at the fence during periods of high water and low smolt movement.

Coho Smolts: A total of 30,005 coho smolts were counted at the fence and included gee trap catches (Table 2). The maximum daily number of smolts captured at the fence was 2,691 and occurred on 28 May (Table B-1, Figure 4). There were a total of 445 fry and pre-smolt coho counted and released during trapping operations and 12 mortalities (Table B-1).

Non-coho Species: Juvenile Dolly Varden were caught in the largest numbers, followed by lampreys (larvae and young adults), juvenile sockeye, juvenile cutthroat, and juvenile steelhead (Table 3, Table B-2).

Biosampling: Length, Weight, and Age

The mean fork length of age-2 smolts was 103.8 mm and the mean weight was 11.4 g (Table 1). Age-3 smolts averaged 118.2 mm and 16.3 g, and age-4 smolts averaged 123.0 mm and 18.0 g. The length-frequency distribution showed substantial overlap between age-2, age-3 and age-4 coho (Figure 5). Age-2 smolts were most numerous in the 110 - 115 mm length class, age-3 and age-4 smolts were most numerous in the 120 - 125 mm length class. Age-3 coho smolts were significantly larger than age-2 smolts (t-test, $p < 0.05$). Overall, coho smolts averaged 107.5 mm in length. The calculated freshwater age structure of coho smolts was 83.2% age-2, 16.1% age-3, and 0.7% age-4 (Table 1).

Coded-wire Tagging

Mean tag retention was 91.9% for tag code 28-01-08, 99.9% for tag code 28-01-09, and 99.8% for tag code 28-01-12 (Table 4). Crews conducted 13 tests for tag code 28-01-08 for a total of 2,907 samples with 235 tag losses, 5 tests for tag code 28-01-09 for a total of 1,000 samples with 1 tag loss, and 4 tests for tag code 28-01-12 for a total of 800 samples with 2 tag losses.

Releases of adipose fin-clipped coho totalled 27,131 (Table 5; Table C-1). Crews recorded 160 mortalities associated with the tagging process. The total number of coho smolts released with coded-wire tags was 26,305 (Table 5). Approximately 9% (2,662) of the captured coho smolts were released untagged during the study period and thus the mark rate of coho smolts released was 1.13 (Table 5). The total number of smolts released was 29,793.

ADULT COHO STUDIES

METHODS

Population Estimates

An aluminum conduit fence anchored to a crib-type sill was constructed at Zolzap Creek. All salmonids caught at the fence were counted and classified by sex. Sex was distinguished on the basis of length and body morphology. Previous studies at Zolzap Creek (Nass 1996b, 1996c, 1997a, 1997b, Nass 2001, Nass and Frith 2001, Baxter et al. 2001, Baxter and Stephens 2002, Baxter and Stephens 2002a, Baxter and Stephens 2002b, Baxter 2003) have shown an absence of jacks in the escapement, and therefore all males were classified as adults. "Jack panels" consisting of 1" wire mesh were used to prevent the passage of small coho through the fence and were used whenever water levels and debris permitted. Each coho was tagged on the operculum with a uniquely numbered Ketchum kurl-lock tag and measured for length. During handling, fish were examined for fin clips or tags that would be associated with coded-wire tagging or mark-recapture studies taking place on the Nass River. All captured fish were released upstream of the fence.

Adult coho abundance downstream of the fence was assessed later in the migration period due to the lack of fish movement past the fence. Delayed migration was the result of persistent low water conditions in Zolzap Creek in the later fall period. During these periods of delayed fish movement, angling was conducted approximately 1 km downstream of the fence in Zolzap Slough to determine relative coho abundance. Live coho were recaptured in upstream surveys and checked for operculum tags. Carcasses were recovered on the fence and during upstream surveys. In 2003, carcasses were recovered primarily in the lower 5 km of the creek.

Biosampling

All live coho captured at the fence were measured for postorbital-hypural length and examined for fin clips and sex. Data recorded from coho captured at the fence were used to

calculate sex ratios and mean-length by sex. Crews attempted to sample at least 25 coho a day for scales (5 scales per fish). Scale samples were sent to Carol Lidstone (Birkenhead Scale Analyses), Lone Butte, BC for age determination. Secondary quality control checks were performed at the scale lab to ensure reliability of the age designations. Scale ages are reported in Gilbert-Rich notation where freshwater age-2 coho (i.e., having survived two winters from egg deposition) have a single freshwater annulus.

Adult returns (calculated by escapement method) and smolt production, by CWT and total populations, were calculated for each brood year where data was available. Smolt output and adult escapement were apportioned between brood years (back-calculated) using the age structure observed in the respective yearly migrations. The sum of freshwater age-2, age-3, and age-4 individuals equals total production for a given brood year. Age composition for smolts and adults by brood year was calculated based on the estimated production. Total survival by brood year was calculated as the age specific adult return divided by the respective smolt production. Smolt-to-spawner recruitment for each brood year was calculated as the number of smolts produced divided by the number of adults in the escapement, by brood year. Similarly, the recruit-to-spawner ratio for each brood year was calculated as the number of adults produced divided by the number of adults in the escapement, by brood year.

Coded-wire Tag Recoveries

Coded-wire tagged smolts were adipose fin-clipped prior to release. Coho smolts at Zolzap Creek were coded-wire tagged in the spring of 2002 (Baxter 2003) during out-migration.

Escapement: Crews examined all coho captured at the fence for the presence or absence of the adipose fin. The contribution and survival of AFC coho to the escapement was determined using methods presented in Bocking et al. (1992) and modified in Nass (1997a). Coded-wire tagged heads were collected from fish captured at the Nass River fishwheels, fish recovered in the native angling fishery below and above the fence, and from carcass recoveries.

Commercial and Sport Harvests: Commercial and sport catches of CWT fish are monitored by the Fisheries and Oceans Canada and various US agencies and compiled in the Mark Recovery Program (MRP) and in the ADF&G mark tag and age lab online searchable database. Data on CWT releases and recaptures are used to estimate the number of fish from a particular stock that have been harvested in the commercial and sport fishery, as well as determining the spatial and temporal distribution of harvests (Kuhn et al. 1988, Nass 1997a). The estimates include catch (observed catch corrected for sampling effort), expanded catch (estimated catch corrected for unmarked fish), exploitation rate (proportion of CWT coho caught in the fishery), and total return (expanded catch plus escapement).

Geographic Distribution of Harvest: Coded-wire tagged fish in the commercial catch are recorded by Canadian and US fishery Statistical Areas. To estimate number of recoveries for each Canadian area, the observed CWT catch was expanded by the mean catch-sampling ratio observed in the Catch Region (e.g., Northern Troll = Stat. Areas 1, 3, 4, and 6). Similarly, US

troll catch was expanded using the catch sampling ratio by quadrant (e.g., northwest) and the net catch sampling ratios, by district.

RESULTS

Physical Observations

During the period that the adult fence was operational, water temperatures ranged from a maximum of 10 °C in early September to a minimum of 6 °C in mid-October (Table A-1, Figure 3B). Water level ranged from 0.2 m during base flows to 0.7 m during freshets (Table A-1, Figure 3B).

Adult Enumerations

The fence was operated continuously from 24 August to 25 October. A rain on snow event that occurred on 25 October resulted in extreme flow conditions and caused a complete failure of the adult fence. A total of 1,444 adult coho salmon were counted at the fence including 6 coho released untagged (Table 6). Of these, 1,438 adults (adjusted for tag loss) were operculum tagged and released upstream. Maximum daily migration past the fence was 434 adults on 25 October (Table D-1, Figure 6).

For non-coho species captured at the fence, Dolly Varden had the greatest abundance (27), followed by chum salmon (26), cutthroat trout (17), and pink salmon (15). Sockeye salmon (9) and steelhead (1) were also captured at the fence (Table 3). Chum, pink, and sockeye were caught in their greatest numbers in early-mid September. Cutthroat and Dolly Varden were mainly caught in mid-late September. The number of chum and sockeye caught in 2003 were higher than in 2002 but below the 1992-2002 averages (40 and 12 respectively). No population estimates were derived for non-coho species.

Mark-recapture Estimates

Crews examined a total of 372 adult coho carcasses collected on the fence, and in 13 upstream surveys. Surveys were conducted upstream of the fence from 24 October to 11 December at three access locations along the creek. Upstream surveys were conducted on 24 October, 13 November and 11 December at Goat Creek (a tributary); 4, 5, 10, 17, 27 November, and 1, 5 December at upper Zolzap Creek. Of the 372 adult coho examined, 187 were tagged, and 185 were untagged, which resulted in a Peterson population estimate of 2,855 adults (2,476 to 3,292; 95% CL) escaping to Zolzap Creek in 2003 (Table 6). An undetermined number of coho were observed spawning below the fence and in the Zolzap Slough area, so our estimate of 2,855 adult coho is likely underestimated.

Biosampling - Age and Length

A total of 128 coho were sampled for scales, of which 106 were successfully aged (Table 7). Non-aged samples included marine regenerates. Adult males and females had different age compositions which averaged 82.0% and 71.4% freshwater age-2, and 18.0% and 28.6% freshwater age-3 respectively. The overall age composition was 76.4% age-2, and 23.6% age-3. All aged scales were recorded as marine age-1 (i.e., having one marine annulus).

Mean lengths of adult males and females were 45.7 cm (n=815, SD=7.3) and 50.0 cm (n=626, SD=5.5), respectively. Adult male coho were widely distributed over the range of 28 to 66 cm with a mode of 48 cm (Figure 7). Female coho had a mode of 52 cm with a range of 30 to 64 cm. For coho sexed during processing, adult males captured at the fence (n=815) were more abundant than females (n=626).

Coded-wire Tag Recoveries

Escapement: Crews examined 1,416 adult coho at the fence for fin clips of which 432 were AFC (30.5%; Table 8). An estimated 871 adipose-clipped adult coho returned to Zolzap Creek in 2003. An undetermined number of AFC coho spawned below the fence and in the Zolzap slough area. Smolt to spawner survival (i.e., includes natural and harvest mortality) for adult coho was estimated at 7.0%.

Twenty-four (24) CWT heads were collected at Zolzap Creek. Of these recoveries, 23 were from the native angling fishery below the fence and one was a carcass recovery. In addition, two coho with adipose clips were recovered at the Nass River fishwheels. All of the CWT recoveries from Zolzap Creek were from the 2002 release at Zolzap Creek (codes 28-01-10 and 28-01-11).

Commercial and Sport Harvests: Total observed Zolzap Creek coho CWT recoveries were 8 and 131 for Canadian and US (Alaska) fisheries, respectively (Table 9). Observed sport recoveries totalled 0 for the Canadian fisheries and 8 for the Alaskan fishery. All CWT recoveries were from the 2002 release year. US troll and net catch to sample ratios were 2.8 and 8.8, respectively (Table 9). Estimated Zolzap Creek CWT coho catches were 49 (9%) and 496 (91%) for Canadian and US fisheries, respectively, and the total in-river angling fishery (including Nisga'a food fishery and non-Nisga'a sport harvests) at Zolzap Creek harvested an estimated 40 CWT coho (Table 9).

Expanded Canadian and US catches were 51 and 519, respectively, for a total of 570 using the CWT mark ratio at release (i.e., MRP method) (Table 10). Expanded Canadian and US catches were 160 and 1,626, respectively, for a total of 1,786 using the adipose clip ratio at recovery (i.e., escapement method). Estimated total adult return for Zolzap Creek coho was 1,473 and 4,641 using the MRP and escapement methods, respectively (Table 10).

Of the total commercial catch of Zolzap Creek coho, Canadian fisheries accounted for 9.5% and the US accounted for 90.5% of the total commercial catch of Zolzap Creek coho

(Table 11). US troll and net fisheries accounted for 62.4% and 37.6% of the total US commercial catch, respectively. Canadian troll and net fisheries accounted for 87.8% and 12.2% of the total Canadian commercial catch. Commercial harvest of Zolzap Creek coho occurred over a wide area ranging from Canadian Statistical Area 5 to the US Northern Outside Statistical Area in Alaska (Figure 8). US harvests were largest in the Southern Inside Statistical Area for the net fishery (16.0%) and the Central Outside Statistical Area for the troll fishery (21.9%; Table 11).

Total exploitation rate (Canadian and US combined) on Zolzap Creek coho in 2003 was 40.1% (Table 12). Total Canadian exploitation rate was 6.1% (2.9% troll, 0.4% net, 2.2% terminal harvest by Nisga'a, and 0.5% terminal sport harvest) and total US exploitation rate was 34.0% (19.9% troll, 12.0% net, and 2.1% sport). Total survival based on CWT returns was 11.8% (Table 12).

DISCUSSION

Over the past 12 years of monitoring, the average number of smolts enumerated leaving Zolzap Creek was 28,459 (Table 12). For the 1990-1999 time period for which complete brood year information is available, the average age composition of the smolt population was 68.1% age-2, 31.3% age-3, and 0.6% age-4 (Table 13).

Adult coho enumerated at the fence in 2003 (1,444) accounted for 50.6% of the Peterson population estimate (2,855). Therefore, approximately 1,411 adults entered Zolzap Creek during the period in which the fence was not operational. An undetermined number of coho were observed spawning below the fence and in Zolzap Slough. The observed native fishery harvested 24 coho below the fence of which 7 were estimated to have been CWT (based on mark rate observed at the fence). The observed sport fishery harvested 27 coho below the fence of which 8 were estimated to have been CWT (based on mark rate observed at the fence). Average escapement estimates for 1992 - 2002 was 1,527 (Table 12).

Data from 1992 to 2002 have indicated that there are no jacks in the Zolzap Creek escapement (Nass 1996b, 1996c, 1997a, 1997b, 2001, Nass and Frith 2001, Baxter et al. 2001, Baxter and Stephens 2002, Baxter and Stephens 2002a, Baxter and Stephens 2002b, Baxter 2003). In 2003, CWT and scale ageing data have confirmed again the absence of jacks in the population. There were 23 heads taken at Zolzap Creek for CWT sampling from coho measured between 29 and 52 cm (post-orbital-hypural) and all were found to be from 2002 releases. A post-orbital-hypural length of 35 cm has been used in previous studies at other BC streams to designate jacks in the escapement and is based on CWT analysis. Both the CWT analysis and scale ageing show that coho less than 35 cm from Zolzap Creek in 2003 were marine age-1.

The Department of Fisheries and Oceans, Canada, operates a juvenile and adult fence site at Lachmach River, BC which is used as a Northern BC wild coho indicator stock. Exploitation rates for Lachmach coho have ranged from 21.8% to 70% for the 1994-2001 period (Holtby et al. 1999, Barry Finnegan, PBS, Nanaimo, pers. comm.). These exploitation rates are very similar to Zolzap exploitation rates for the 1994-1999 time period (Figure 9). Total survival for Lachmach

coho has ranged from 5.5% (1997) to 17.4% (1994) and has been consistently higher than Zolzap Creek survivals (Figure 10).

In Alaska, comprehensive information exists for several southeast stocks, including Hugh Smith Lake (Southern Inside Statistical Area, see Figure 8), which has been monitored since 1982. Preliminary data for the 2003 return suggests exploitation rates of 3.0% Canadian and 53.5% US (56.5% total; Leon Shaul, Alaska Dept. of Fish and Game, Douglas, AK, pers. comm.). Southeast Alaska and Canadian fisheries accounted for approximately 94.5% and 5.5% of the commercial catch of Hugh Smith coho, respectively. The total exploitation rate on Hugh Smith coho (56.5%) was much higher compared to exploitation rates on Zolzap Creek coho (40.1%) in 2003. Preliminary CWT data for the 2003 return of Hugh Smith coho suggest a survival rate of 14.2% which is higher than for Zolzap Creek coho at 11.8%. Hugh Smith coho have had substantially higher survivals (range 6.6% to 19.5%) compared to Zolzap coho (range 2.4% to 11.8%) in the past ten years.

Zolzap Creek CWT coho have been subjected to total exploitation rates between 19.9% and 72.3% and have had smolt-adult survival rates between 2.1% and 11.8% over the period 1992 to 2003 (Table 12, Figures 9 and 10). 2003 survivals were the highest recorded since 1992. Canadian fisheries have had exploitation rates between 0% and 21.4% on Zolzap CWT coho, while US fisheries ranged between 16.6% and 54.8% (Figure 11). Of the total catch of Zolzap Creek coho, Canadian fisheries have averaged 17.5% and the US has averaged 82.5%, over eleven years (Table 12).

Total smolt production by brood year averaged 27,702 (1990 - 1999) and was composed primarily of freshwater age-2 fish (68.1%; Table 13). Adult production by brood year averaged 3,234 (1990 - 1998) and was 59.0% age-2 fish. Age composition at return was substantially different from that observed in the respective smolt populations and varied widely. Freshwater age-4 fish were absent from all adult escapements with the exception of the 1995 brood year. Total smolt-adult return by brood year of all Zolzap coho (unmarked + CWT) averaged 11.6% (1990-1997; Table 13). Total smolt-adult return of Zolzap CWT coho was substantially lower at 4.8%. Higher survival for all coho compared to CWT coho is likely due to a significant number of unmarked smolts leaving Zolzap during non-operational periods (Nass 1996c). The effects of these conditions are evident from the historical data which shows the AFC at release has been roughly two to three times that of the AFC rate at return for the period 1993-2003 at Zolzap Creek (Table 8). Therefore, by using only CWT fish, the uncertainty around the number of fish released is eliminated and produces a more accurate estimate of survival for Zolzap coho smolts.

Estimates of total survival and exploitation are based on the assumption that all CWT coho are recovered in fisheries or on the spawning grounds. At Zolzap Creek, it is possible that the escapement of AFC coho is underestimated due to straying. Coho are known to spawn downstream of Zolzap Creek in Zolzap Slough (a side channel to the Nass River) where some CWT coho may return. In addition, a total of two adipose-clipped coho were recovered in the fishwheels above Zolzap Creek in 2003 (both were from the 2002 release at Zolzap Creek), which tends to confirm our theory of straying. Straying would affect Zolzap Creek survival and exploitation estimates by underestimating survival and overestimating exploitation rates.

Zolzap Creek coho survivals may also be lower than Lachmach and Hugh Smith coho due to predator/prey interactions, with Zolzap Creek coho being more vulnerable to predation during their outmigration. Hugh Smith and Lachmach are both coastal systems and empty directly into marine waters. In contrast, Zolzap Creek empties into the Nass River and coho smolts must migrate approximately 33 km through Riverine habitat until they reach the ocean. This may predispose the smolts to a higher level of predation along the way.

Persistent low water conditions at Zolzap Creek in the fall result in coho holding below the fence in Zolzap Slough until water levels rise. During certain low water years, this may result in coho spawning in the Slough area or pulsing through after the fence is demobilized. During these times, the run timing of the returning adult coho may be more an artifact of water levels rather than natural run timing. High water conditions and flash flooding conditions have occurred during the last two years (2002 and 2003) and intermittently since the start of the program. Peak flood conditions in 2002 and 2003 resulted in the complete failure of the fence structure and large capital infrastructure costs. It is recommended that during subsequent years, water levels at the adult fence be monitored very closely and if the risk of flooding is present some or all of the panels be removed until the risk is over. During these events, increased effort will be apportioned to upstream surveys to ensure a complete census of returning coho.

The number of smolts per spawner was 17.5 for the 1999 brood year. This value is conservative as the number of smolts released was likely underestimated. The number of recruits per spawner was 3.0 for the 1999 brood year (Table 13).

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TABLES

Table 1. Age-length distribution of Zolzap Creek coho smolts, 2003.

Size-Class (mm)	Age Sample (X)	Age-groups in X			Length Sample (Y)	Calculated Age Representation in Y		
		2	3	4		2	3	4
70	7	7	0	0	9	9.0	0.0	0.0
75	9	9	0	0	14	14.0	0.0	0.0
80	23	23	0	0	31	31.0	0.0	0.0
85	42	42	0	0	69	69.0	0.0	0.0
90	47	47	0	0	73	73.0	0.0	0.0
95	48	41	7	0	69	58.9	10.1	0.0
100	48	41	7	0	75	64.1	10.9	0.0
105	61	53	8	0	111	96.4	14.6	0.0
110	69	62	7	0	122	109.6	12.4	0.0
115	48	43	4	1	98	87.8	8.2	2.0
120	35	19	15	1	77	41.8	33.0	2.2
125	22	11	11	0	38	19.0	19.0	0.0
130	16	4	11	1	28	7.0	19.3	1.8
135	2	1	1	0	7	3.5	3.5	0.0
140	0	0	0	0	3	1.5	1.5	0.0
145	0	0	0	0	0	0.0	0.0	0.0
150	0	0	0	0	0	0.0	0.0	0.0
Mean length					107.5	103.8	118.2	123.0
SD					37.9	13.4	11.5	6.8
Mean weight (g)					12.3	11.4	16.3	18.0
SD					4.6	4.1	4.5	3.3
Total samples	477	403	71	3	824	686	132	6
% contribution		84.5	14.9	0.6		83.2	16.1	0.7

Table 2. Coho smolt catch at Zolzap Creek enumeration fence, by week, in 2003.

Week ending	Catch
03-May	744
10-May	1,675
17-May	5,819
24-May	8,748
31-May	8,614
07-Jun	4,405
Total	30,005

Table 3. Non-coho catch at the spring juvenile and fall adult fences at Zolzap Creek, 1992-2003[a].

Species	Time/lifestage	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	92-02 Avg.
Pink	Fall Adult	115	149	251	52	72	44	23	71	33	60	17	15	81
Chum	Spring Juvenile						344	549	79	5	7	12	0	166
	Fall Adult	30	111	68	8	19	42	24	32	24	80	5	26	40
Sockeye	Spring Juvenile	4	244	328	189	119	0	798	231	98	8	4	173	184
	Fall Adult	4	11	28	7	0	39	10	11	5	15	1	9	12
Cutthroat	Spring Juvenile	12	69	36	67	121	42	268	141	259	138	118	99	116
	Spring Adult	308	278	224	43	55	2	117	30	13	45	135	20	114
	Fall Adult	17	27	14	28	18	12	14	28	18	12	12	17	18
Dolly Varden	Spring Juvenile	682	309	339	518	711	337	732	647	1095	740	483	735	599
	Spring Adult	644	728	1,529	28	44	7	25	5	11	10	89	5	284
	Fall Adult	9	21	10	81	39	21	30	174	27	136	3	27	50
Steelhead	Spring Juvenile	11	15	36	12	30	4	82	33	41	39	23	4	30
	Spring Adult	33	0	5	0	0	0	0	0	0	1	0	0	4
	Fall Adult	5	0	2	0	0	0	4	1	4	4	4	1	2
Lamprey[b]	Spring Juvenile	749	906	1,277	2,314	1,333	1,794	2,264	1,806	539	1,027	711	357	1,338
	Spring Adult	-	-	-	-	28	97	144	199	177	295	193	119	162
	Fall Adult	-	-	-	2	16	4	1	0	0	0	0	0	3

[a] Trapping effort not equal between years.

[b] Adults and juveniles not distingushed for period 1992 - 1995.

Table 4. Coded-wire tag retention rates for Zolzap Creek coho smolts, 2003.

Sampling Date	Tagging Date	Tag code	Hours held	Sample size	No. fish no tag	Percent retention
03-May	01-May	28-01-08	48	200	3	98.5
04-May	03-May	28-01-08	24	200	0	100
06-May	04-May	28-01-08	48	201	0	100
07-May	06-May	28-01-08	24	200	0	100
10-May	08-May	28-01-08	48	181	1	99.4
11-May	10-May	28-01-08	24	200	0	100
12-May	11-May	28-01-08	24	200	1	99.5
13-May	12-May	28-01-08	24	200	3	98.5
15-May	14-May	28-01-08	24	200	0	100
16-May	15-May	28-01-08	24	200	0	100
17-May	16-May	28-01-08	24	200	0	100
19-May	18-May	28-01-08	24	525	227	56.8
21-May	19-May	28-01-08	48	200	0	100
Subtotal				2,907	235	91.9
22-May	21-May	28-01-09	24	200	0	100
23-May	22-May	28-01-09	24	200	1	99.5
26-May	24-May	28-01-09	48	200	0	100
27-May	26-May	28-01-09	24	200	0	100
28-May	27-May	28-01-09	24	200	0	100
Subtotal				1,000	1	99.9
30-May	29-May	28-01-12	24	200	0	100
03-Jun	01-Jun	28-01-12	48	200	0	100
04-Jun	03-Jun	28-01-12	24	200	1	99.5
05-Jun	04-Jun	28-01-12	24	200	1	99.5
Subtotal				800	2	99.8
Grand Total				4,707	238	94.9

Table 5. Coded-wire tagged coho smolt releases from Zolzap Creek, 2003.

Tag code	Tagging dates	No. AFC	Tag morts	No. released AFC	No. tagged [a]	No. AFC only [b]	No. released untagged [c]	Total release [d]	CWT mark rate [e]
280108	1 May - 19 May	9,955	90	9,865	9,067	798	50	9,915	1.09
280109	20 May - 28 May	9,932	41	9,921	9,911	10	2,318	12,239	1.23
280112	29 May - 5 June	7,375	29	7,345	7,327	18	294	7,639	1.04
	Total	27,262	160	27,131	26,305	826	2,662	29,793	1.13

[a] No. tagged (corrected for tag loss) = No. released AFC - (No. released AFC * No. lost tags / No. sampled); see Table 4.

[b] No. AFC only = No. released AFC - No. tagged

[c] No. released untagged = the number of unmarked fish released which belong to the same group as the tagged and AFC only fish.

[d] Total release = No. tagged + AFC only + untagged

[e] CWT mark rate = Total release / No. tagged

Table 6. Fence enumerations, carcass recoveries, and Petersen population estimates for adult coho escapement at Zolzap Creek, 2003.

Item	Adults	Total
Number live coho captured at fence	1,444	1,444
Number of live coho released untagged	6	6
Number live coho operculum tagged	1,438	1,438
Number coho carcasses recovered	372	372
Number of coho carcasses recovered untagged	185	185
Number of coho carcasses recovered tagged	187	187
Petersen estimate	2,855	2,855
Upper 95% CL	3,292	3,292
Lower 95% CL	2,476	2,476

Table 7. Freshwater age distribution of adult coho at Zolzap Creek, 2003.

Sex	Age-2		Age-3		Total aged	Total unaged	Total sampled
	No.	%	No.	%			
Adult males	41	82.0	9	18.0	50	16	66
Adult females	40	71.4	16	28.6	56	6	62
Total adults	81	76.4	25	23.6	106	22	128

Table 8. Estimates of total escapement of adipose clipped coho and contribution to escapement at Zolzap Creek, 1993-2003.

Escapement Year	No. examined (A)	No. with adipose clips (B)	% AFC (C=B/Ax100)	Population estimate (D)	% sampled (E=A/Dx100)	Estimated adipose clips (F=B/AxD)	No. smolts [a] AFC	unclipped	% AFC	Contribution to escap.[b]	Smolt to spawner (%) [c]
1993	784	191	24.4	1,048	74.8	255	33,923	6,678	83.6	306	0.8
1994	2,416	499	20.7	2,536	95.3	524	22,986	3,348	87.3	600	2.3
1995	906	308	34.0	908	99.8	309	29,615	4,804	86.0	359	1.0
1996	1,030	218	21.2	1,039	99.1	220	10,166	2,203	82.2	268	2.2
1997	462	201	43.5	470	98.3	204	20,625	1,265	94.2	206	0.9
1998	963	212	22.0	967	99.6	213	13,566	992	93.2	228	1.6
1999	1,294	451	34.9	1,393	92.9	486	13,950	1,771	88.7	547	3.5
2000	409	260	63.6	456	89.7	290	14,591	233	98.4	295	2.0
2001	1,893	1,155	61.0	1,897	99.8	1,157	30,304	3,212	90.4	1,280	3.8
2002	1,905	883	46.4	3,233	58.9	1,499	22,385	4,427	83.5	1,795	6.7
2003	1,416	432	30.5	2,855	49.6	871	12,412	468	96.4	904	7.0
Avg.	1,206	438	37	1,527	91	516	20,411	2,673	89	588	2.5

[a] smolt releases of the previous migration year; an unknown number of additional unclipped releases were likely.

[b] marked contribution to escapement = estimated adipose clips * (clipped + unclipped) / clipped.

[c] % survival = estimated AFC + AFC below the fence / AFC smolts* 100.

Table 9. Estimated Canadian and American commercial and sport harvest of Zolzap Creek CWT coho in 2003 using tag recovery data (Mark Recovery Program, Fisheries and Oceans, Canada and ADF&G mark tag and age lab, online searchable database).

Tag	Observed CWT catch [a]				Catch-sample ratio [b]			Estimated CWT catch [c]			
code	N. Troll	N. Net	Sport	Total	N. Troll	N. Net	Sport	N. Troll	N. Net	Sport	Total
Canadian											
28-01-10	5	1	0	6	6.4	0.0	0.0	32	3	0	35
28-01-11	1	1	0	2	10.7	3.1	0.0	11	3	0	14
Total	6	2	0	8	7.1	3.1	0.0	43	6	0	49
American											
28-01-10	94	18	8	120	2.8	9.2	3.8	265	166	31	463
28-01-11	9	2	0	11	2.8	4.4	0.0	25	9	0	34
Total	103	20	8	131	2.8	8.8	3.8	290	175	31	496
Total	109	22	8	139	3.1	8.2	3.8	333	181	31	545

Total commercial	514
Total sport	31
Total in-river angling fishery [d]	40
Total escapement [e]	873
Total CWT	1,457

[a] Observed CWT = CWT's recovered from the commercial and sport catch

[b] Cumulative catch-sample ratio = total coho catch / total coho sampled

[c] Estimated CWT = observed CWT catch * catch sampling ratio

[d] includes observed harvest (Nisga'a and non-Nisga'a) and estimation using mark rates observed at fence.

[e] Estimated CWT's (adipose clips corrected for tag loss at return) including those below the fence, and at the fishwheels; see Table 8

Table 10. Expanded Canadian and American commercial and sport harvest of Zolzap Creek coho and estimated total return in 2003 from 2002 smolt year.

Tag code	Total release	Smolts tagged [a]	Mark rate [b]	Expanded catch [c]									Contri-bution escap.	Total return [d]
				Canadian				American				Grand Total		
				Troll	Net	Sport	Total	Troll	Net	Sport	Total			
28-01-10	10,553	10,097	1.05	33	3	0	37	277	174	32	483	520		
28-01-11	2,327	2,221	1.05	11	3	0	14	26	9	0	35	50		
Total 1 [e]	12,880	12,318	1.05	45	6	0	51	303	183	32	519	570	904	1,473
Total 2 [f]			3.28	140	20	0	160	951	574	100	1,626	1,786	2,855	4,641

[a] Number smolts released with tags (corrected for tag loss), Nass and Frith 1997.

[b] Mark rate at release (= No. released / No. marked) for smolts and Total 1 (MRP method), and mark rate at return for total 2 (Escapement method).

[c] Expanded catch = EST * mark rate at release

[d] Total return = expanded catch + escapement

[e] Total 1 expanded catch is calculated using the total mark rate at release and the total estimated catch for all tag codes (Table 9).

[f] Total 2 expanded catch is calculated using the total adipose clip rate at recovery and the total estimated catch for all tag codes (Table 9).

Table 11. Estimated commercial harvest distribution of Zolzap Creek CWT coho by area and gear type, 2003. (Percentage is of total commercial harvest, does not include sport recoveries).

Area [a]	Net	%	Troll	%	Total	%
Canada						
Areas 1-5	6	1.2	43	8.3	49	9.5
subtotal	6	1.2	43	8.3	49	9.5
U.S.A. (Alaska)						
Northern Outside	0	0.0	0	0.0	0	0.0
Central Outside	0	0.0	113	21.9	113	21.9
Southern Outside	77	14.9	55	10.7	131	25.6
Southern Inside	82	16.0	82	15.9	164	31.9
Central Inside	8	1.6	0	0.0	8	1.6
Southern Intermediate	8	1.6	25	4.9	33	6.5
Central Intermediate	0	0.0	7	1.4	7	1.4
Unknown	0	0.0	9	1.7	9	1.7
subtotal	175	34.1	290	56.4	465	90.5
TOTAL	181	35.3	333	64.7	514	100.0

[a] includes respective sub-areas

Table 12. Adult and juvenile coho abundance and smolt-adult survival, by smolt year, at Zolzap Creek, 1992-2003.

Smolt Out-migration				Resulting Escapement			Total Return							Catch			Smolt-total return Surv. (%)	
Smolt Year	Count	Estimate A	CWT B	Return Year	Count	Estimate	Return Year	Expanded C	Estimated CWT D	% Esc	% Can	%US	%Can + US	Return Year	% Can	%US	Expanded C/A	Estimated CWT D/B
1992	40,601	53,000	33,150	1993	794	1,048	1993	2,832	690	37.0	15.5	47.5	63.0	1993	24.6	75.4	5.3	2.1
1993	26,334	51,000	22,649	1994	2,438	2,536	1994	9,645	2,025	27.7	18.6	53.7	72.3	1994	25.7	74.3	18.9	8.9
1994	34,419	41,000	29,319	1995	908	908	1995	3,057	1,069	32.3	12.9	54.8	67.7	1995	19.0	81.0	7.5	3.6
1995	12,369	13,000	10,156	1996	1,039	1,039	1996	3,159	674	39.5	21.4	39.2	60.5	1996	35.3	64.7	24.3	6.6
1996	20,745	23,000	20,519	1997	470	470	1997	1,072	486	45.8	8.8	45.4	54.2	1997	16.2	83.8	4.7	2.4
1997	15,099	18,000	13,566	1998	967	967	1998	1,986	400	54.0	0.0	46.0	46.0	1998	0.0	100.0	11.0	2.9
1998	15,937	19,000	13,900	1999	1,302	1,393	1999	2,808	980	50.5	1.2	48.3	49.5	1999	3.1	96.9	14.8	7.1
1999	15,153	16,000	14,572	2000	409	456	2000	955	623	48.0	11.1	40.9	52.0	2000	21.4	78.6	6.0	4.3
2000	33,934	34,500	30,132	2001	1,897	1,897	2001	3,765	2,315	50.2	7.8	42.0	49.8	2001	15.7	84.3	10.9	7.7
2001	27,948	28,000	22,216	2002	1,918	3,233	2002	4,030	1,874	80.1	3.3	16.6	19.9	2002	16.5	83.5	14.4	8.4
2002	15,001	15,000	12,318	2003	1,444	2,855	2003	4,641	1,457	59.9	6.1	34.0	40.1	2003	15.1	84.9	30.9	11.8
2003	30,005	30,005	26,305	2004	-	-	2004	-	-	-	-	-	-	2004	-	-	-	-
Average	23,962	28,459	20,734		1,235	1,527		3,450	1,145	47.7	9.7	42.6	52.3		17.5	82.5	13.5	6.0

Estimate A = Best estimate of total smolt outmigration based on fence counts and migration patterns.

CWT B = Number of smolts that were Coded-wire tagged during their outmigration.

Estimate C = Expanded catch using total adipose clip rate at recovery and the total estimated catch for all tag codes.

CWT D = Estimated catch and escapement of Zolzap Creek CWT coho by tag code, including commercial, sport, native, fishwheel recoveries.

Table 13. Adult and juvenile coho production by freshwater age class and brood year, Zolzap Creek, 1990-1999[a].

All fish

Brood	Smolt Production (by freshwater age)				Adult Return (by freshwater age)				Smolts (freshwater age)			Escapement (freshwater age)[c]			Smolt to Adult Return Survival (% by freshwater age)			
Year	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Age 4	Total	% Age 2	%Age 3	%Age 4	% Age 2	%Age 3	%Age 4	Age 2	Age 3	Age 4	Overall
1990	28,779	16,371	287	45,437	1,651	3,819	0	5,470	63.3	36.0	0.6	30.2	69.8		5.7	23.3	0.0	12.0
1991	34,629	28,495	910	64,034	5,826	1,794	0	7,620	54.1	44.5	1.4	76.5	23.5		16.8	6.3	0.0	11.9
1992	12,218	4,927	161	17,306	1,263	1,478	0	2,741	70.6	28.5	0.9	46.1	53.9		10.3	30.0	0.0	15.8
1993	7,163	6,233	0	13,396	1,681	313	0	1,994	53.5	46.5	0.0	84.3	15.7		23.5	5.0	0.0	14.9
1994	16,606	6,282	228	23,116	759	1,348	0	2,107	71.8	27.2	1.0	36.0	64.0		4.6	21.5	0.0	9.1
1995	11,718	7,695	256	19,669	638	868	4	1,509	59.6	39.1	1.3	42.2	57.5	0.3	5.4	11.3	1.6	7.7
1996	11,077	6,624	0	17,701	1,940	481	0	2,422	62.6	37.4	0.0	80.1	19.9	0.0	17.5	7.3	0.0	13.7
1997	9,088	1,553	0	10,641	465	331	0	796	85.4	14.6	0.0	58.4	41.6	0.0	5.1	21.3	0.0	7.5
1998	32,948	8,344	0	41,292	3,434	1,012	0	4,445	79.8	20.2	0.0	77.2	22.8	0.0	10.4	12.1	0.0	10.8
1999	19,656	4,560	210	24,426	3,018	1,095	-	4,114	80.5	18.7	0.9	73.4	26.6	-	15.4	24.0	-	16.8
2000[a]	10,440	4,830	-	15,270	3,546	-	-	3,546	68.4	31.6	-				34.0	-	-	23.2
2001[a]	24,960	-	-	24,960	-	-	-	-	100.0	-	-							
Avg[b]	18,388	9,108	205	27,702	1,962	1,272	0.5	3,234	68.1	31.3	0.6	59.0	41.0	0.1	11.1	15.8	0.2	11.6

CWT's

Brood	Smolt Production (by freshwater age)				Adult return (by freshwater age)				Smolts (freshwater age)			Escapement (freshwater age)[c]			Smolt to Adult Return Survival (% by freshwater age)			
Year	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Age 4	Total	% Age 2	%Age 3	%Age 4	% Age 2	%Age 3	%Age 4	Age 2	Age 3	Age 4	Overall
1990	18,000	7,270	205	25,476	402	802	0	1,204	70.7	28.5	0.8	33.4	66.6		2.2	11.0	0.0	4.7
1991	15,379	20,377	711	36,466	1,223	628	0	1,851	42.2	55.9	1.9	66.1	33.9		8.0	3.1	0.0	5.1
1992	8,737	3,849	144	12,730	441	315	0	757	68.6	30.2	1.1	58.3	41.7		5.1	8.2	0.0	5.9
1993	5,596	5,561	0	11,157	359	142	0	500	50.2	49.8	0.0	71.6	28.4		6.4	2.6	0.0	4.5
1994	14,815	4,735	167	19,716	344	272	0	616	75.1	24.0	0.8	55.9	44.1	0.0	2.3	5.7	0.0	3.1
1995	8,831	5,630	233	14,694	128	303	6	437	60.1	38.3	1.6	29.4	69.3	1.3	1.5	5.4	2.4	3.0
1996	8,104	6,033	0	14,137	677	314	0	991	57.3	42.7	0.0	68.3	31.7	0.0	8.4	5.2	0.0	7.0
1997	8,227	1,356	0	9,633	303	204	0	507	85.9	14.1	0.0	59.8	40.2	0.0	3.7	15.0	0.0	5.3
1998	28,776	6,620	0	35,396	2,112	470	0	2,582	81.3	18.7	0.0	81.8	18.2	0.0	7.3	7.1	0.0	-
1999	15,596	3,745	184	19,524	1,404	344	-	1,748	79.9	19.2	0.9	80.3	19.7	-	9.0	9.2	-	-
2000[a]	8,573	4,235	-	12,808	1,114	-	-	1,114	66.9	33.1	-				13.0	-	-	
2001[a]	21,886	-	-	21,886	-	-	-	-	100.0	-	-							
Avg[b]	13,211	6,517	164	19,893	666	383	1	1,049	67.1	32.1	0.7	58.3	41.6	0.3	4.7	7.0	0.3	4.8

Brood	All fish		CWT's	
Year	smolts/spawner	recruits/spawner	smolts/spawner	recruits/spawner
1990				
1991				
1992	11.1	1.8	8.2	0.5
1993	12.8	1.9	10.6	0.5
1994	9.1	0.8	7.8	0.2
1995	21.7	1.7	16.2	0.5
1996	17.0	2.3	13.6	1.0
1997	22.6	1.7	20.5	1.1
1998	42.7	4.6	36.6	2.7
1999	17.5	3.0	14.0	1.3
Avg	19.3	2.2	15.9	1.0

[a] (-) Incomplete data for 2000 and 2001, to be completed with data from subsequent returns.

[b] average for "Total" includes years for which complete production data is available.

[c] Age composition of adult escapement return for brood year.

FIGURES

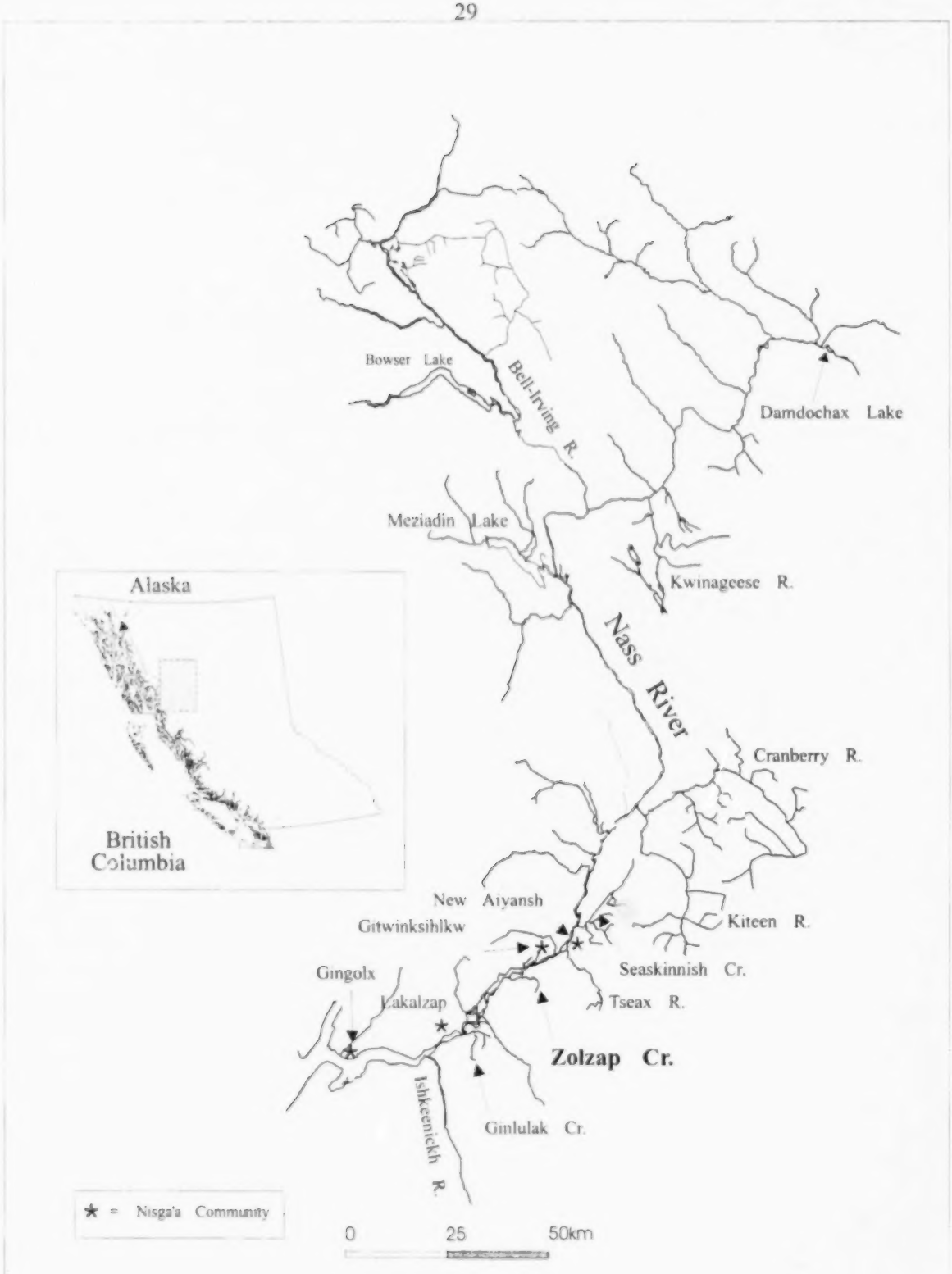

Figure 1. The Nass River watershed, British Columbia.

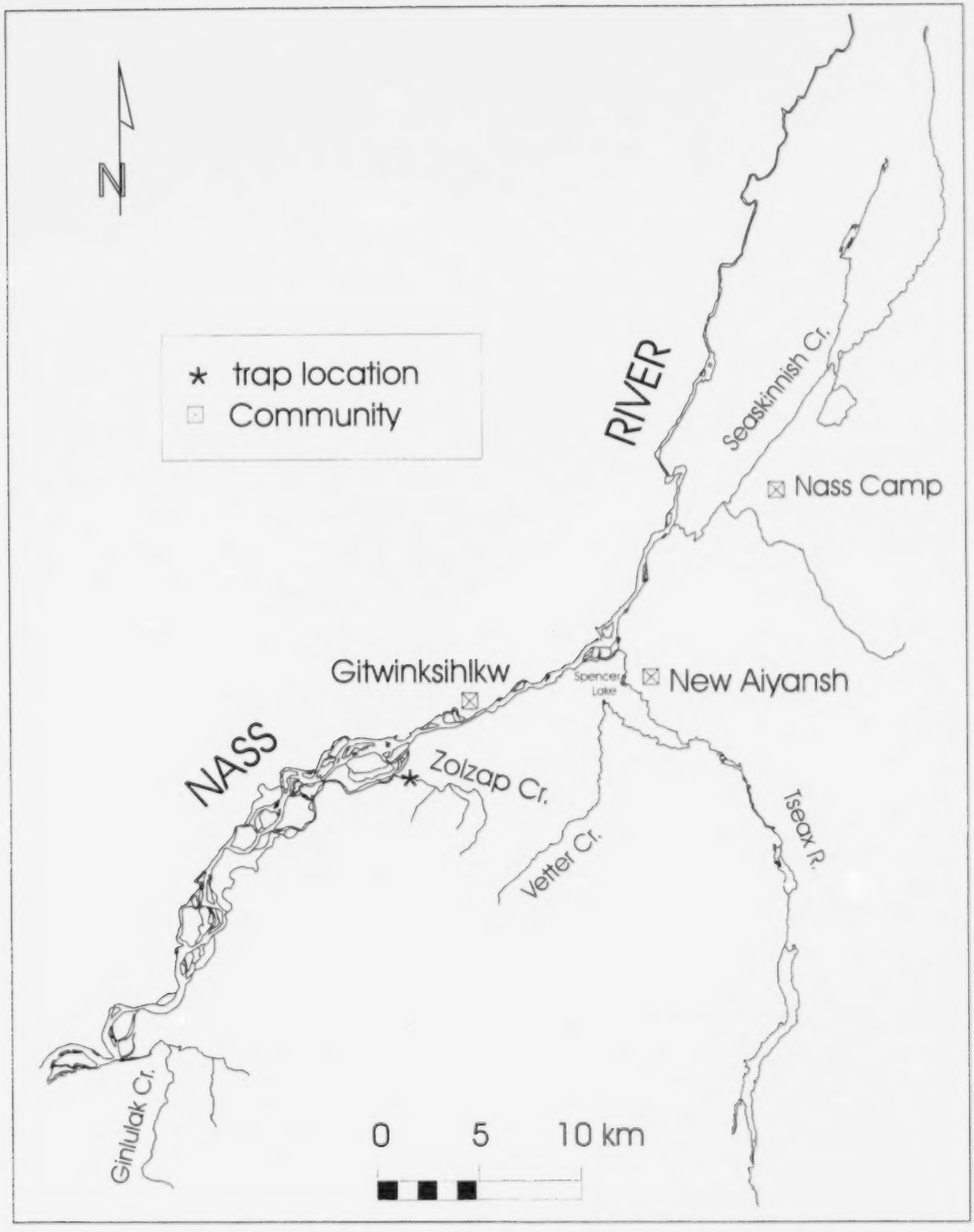

Figure 2. Zolzap Creek and location of enumeration fence.

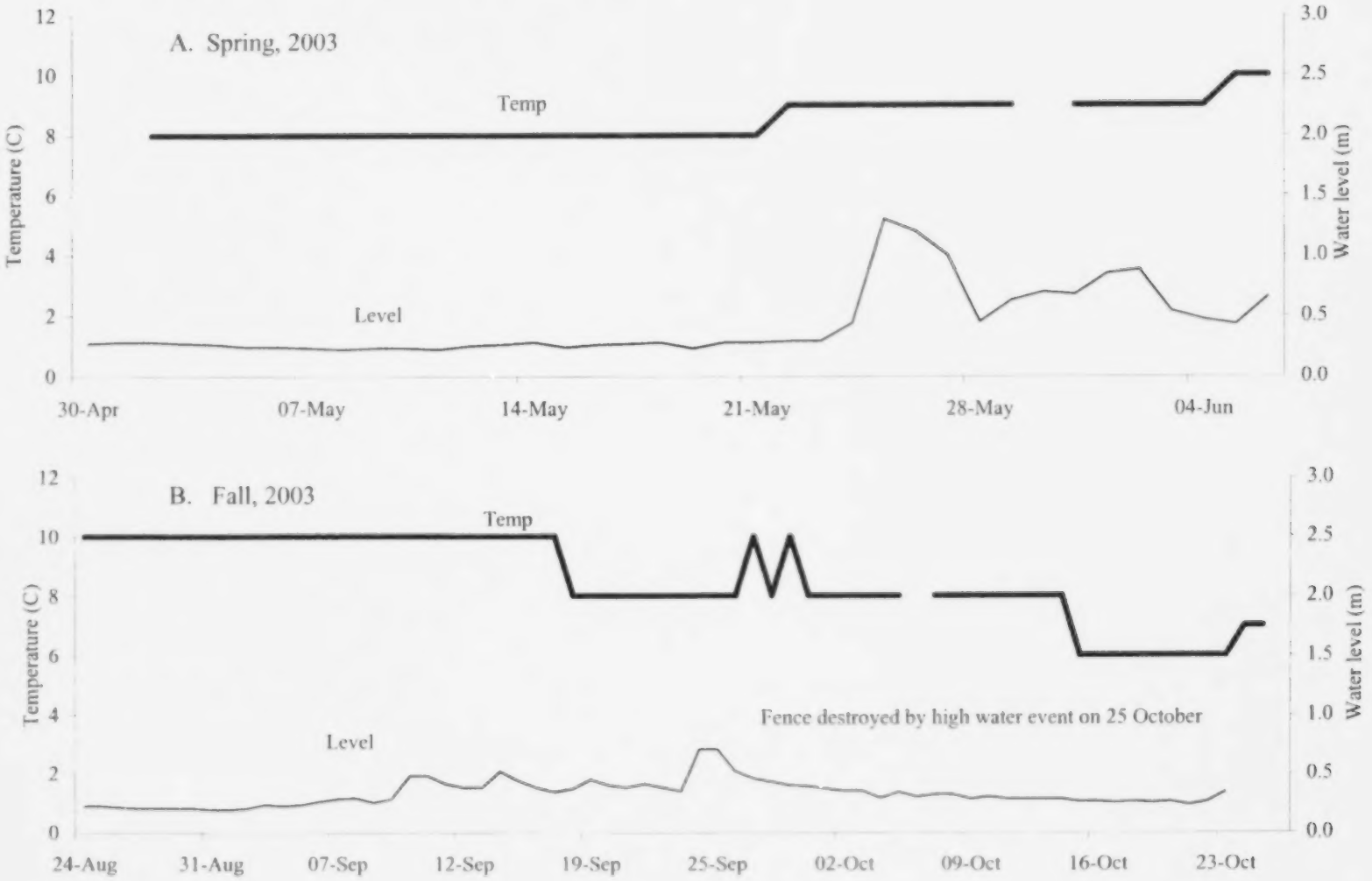

Figure 3. Water level and temperature at Zolzap Creek, 2003.

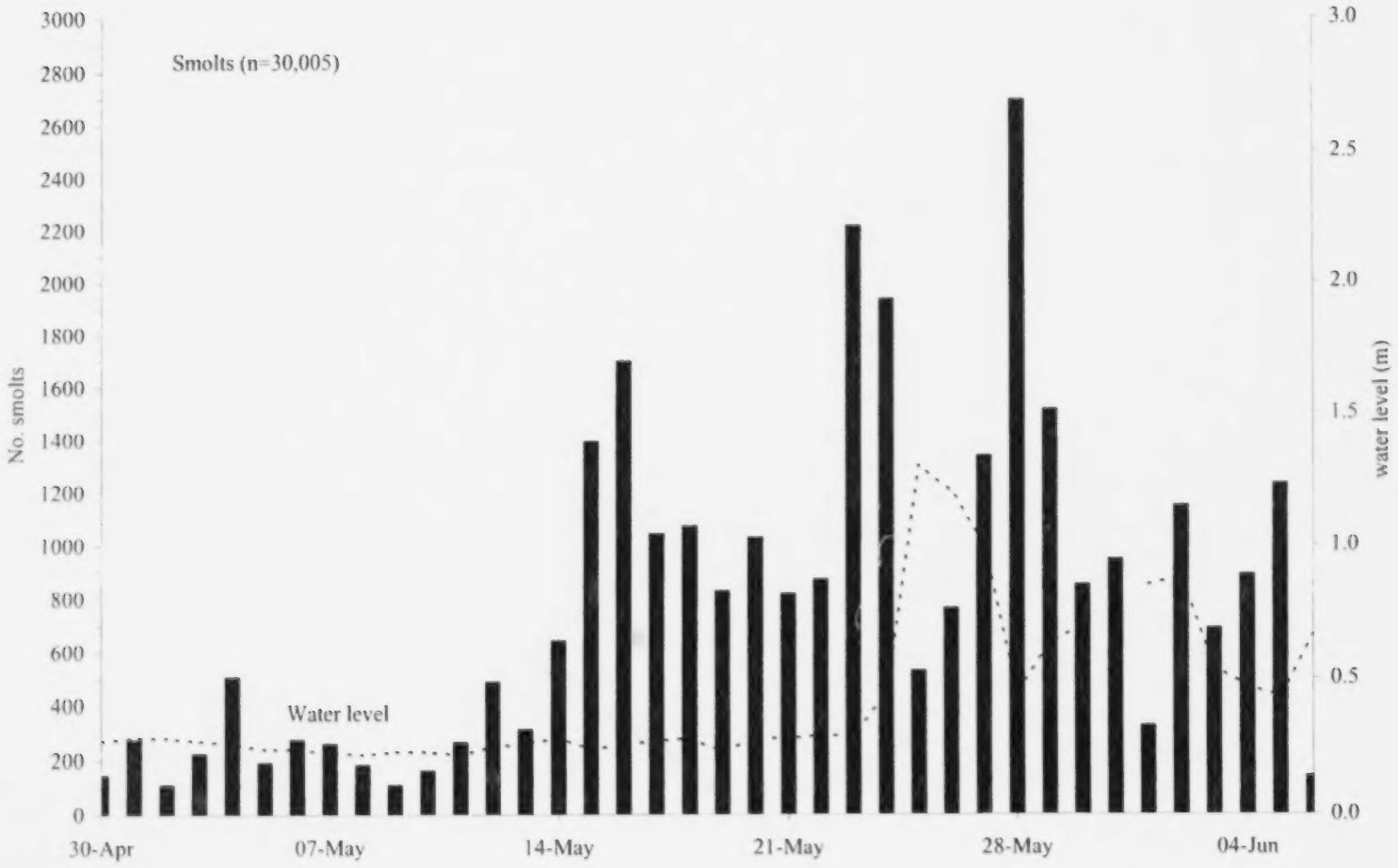

Figure 4. Daily migration of coho smolts at Zolzap Creek, 30 April - 6 June, 2003.

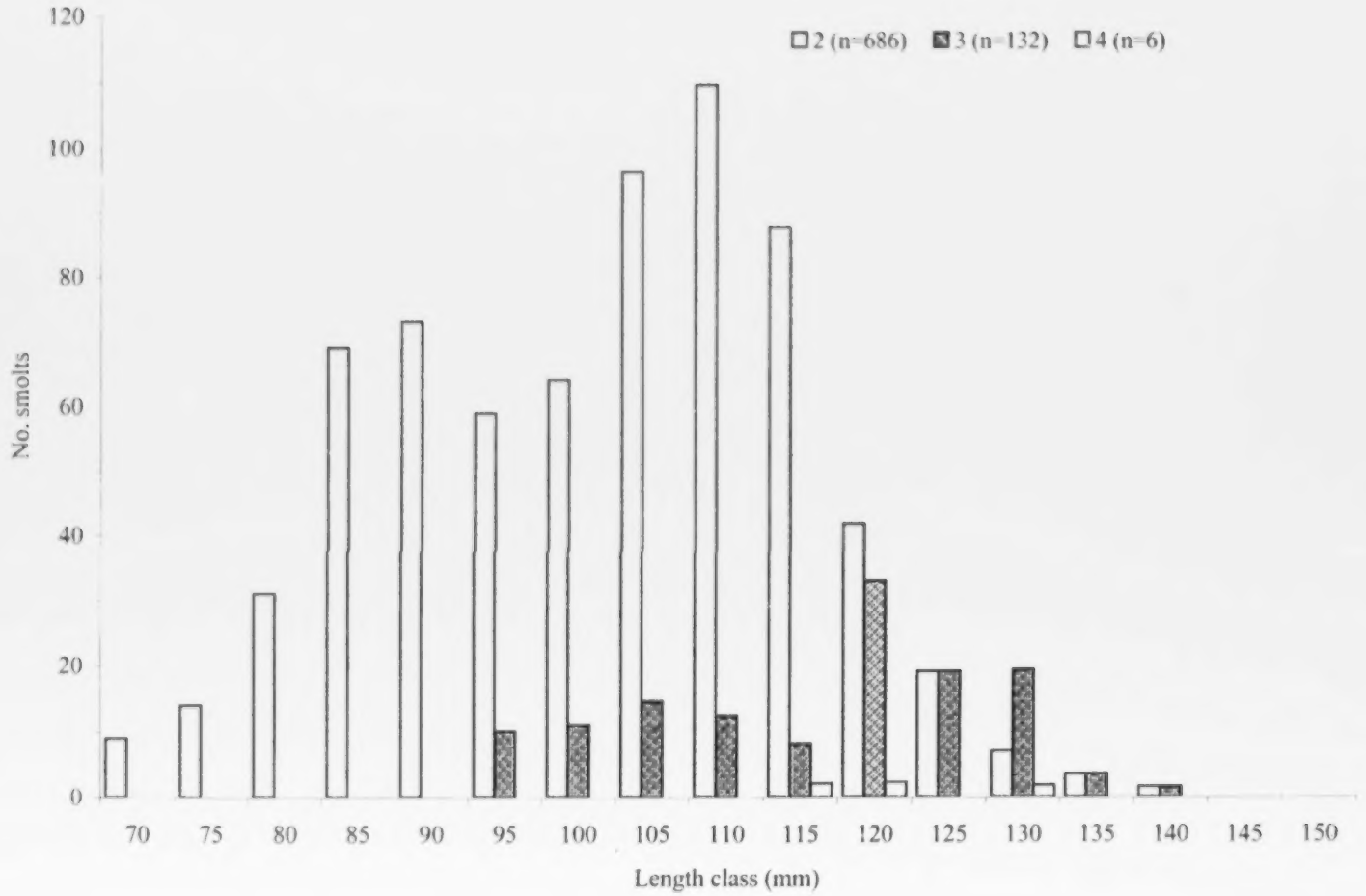

Figure 5. Length-frequency and calculated age distribution of Zolzap Creek coho smolts, 2003.

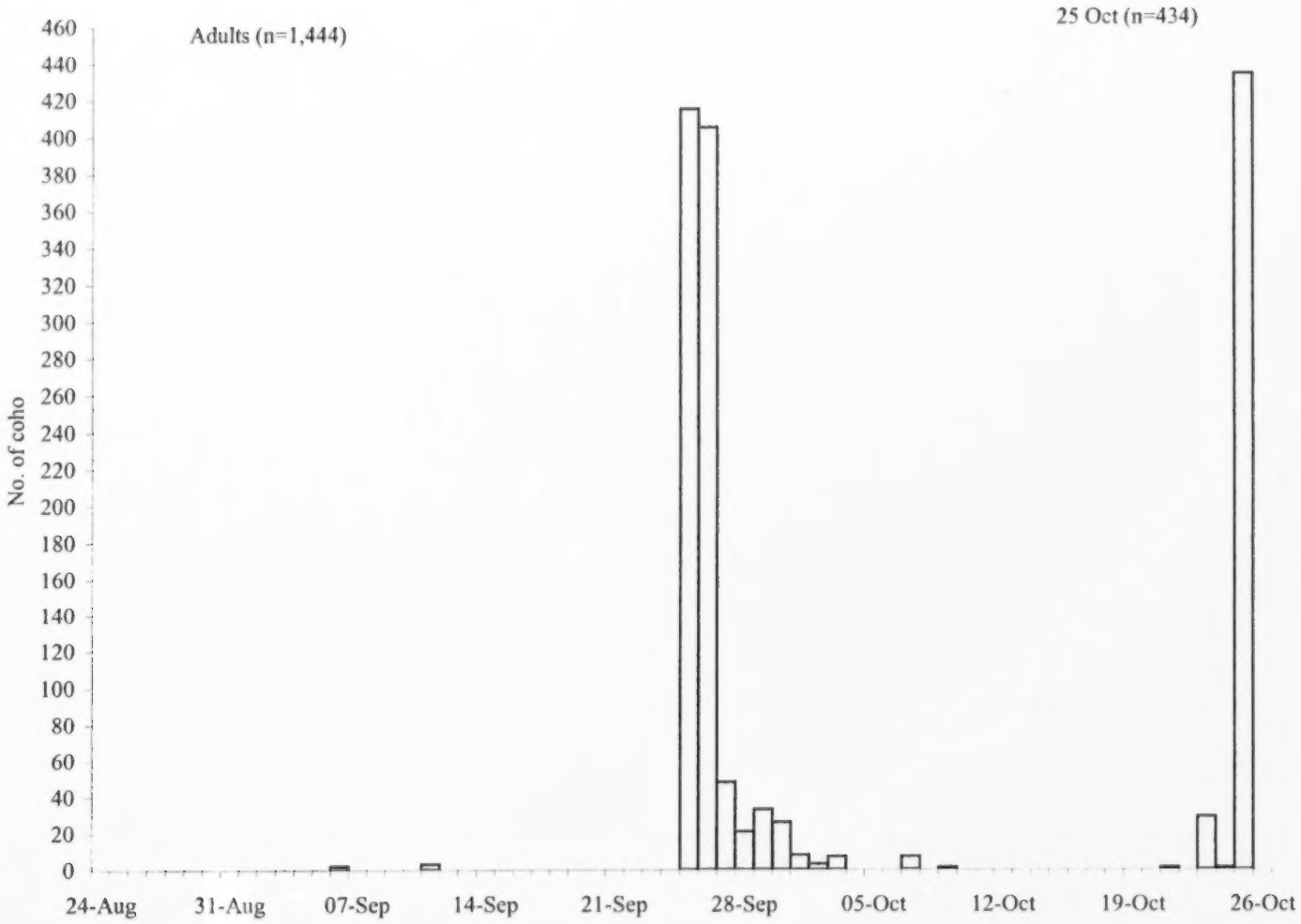

Figure 6. Daily counts of adult coho at the Zolzap Creek enumeration fence, 24 August - 25 October, 2003.

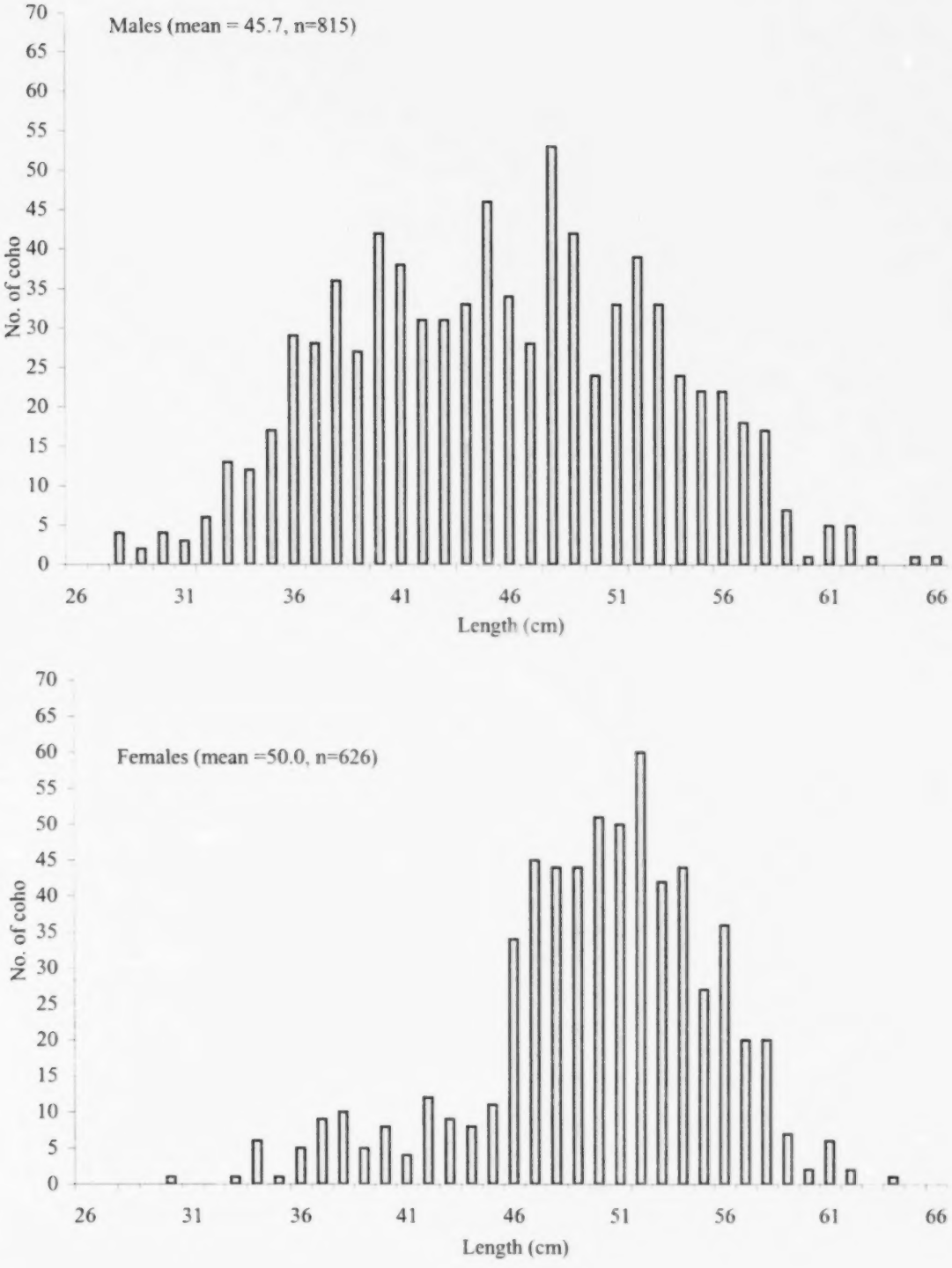

Figure 7. Length-frequency distribution of coho, by sex, Zolzap Creek, 2003.

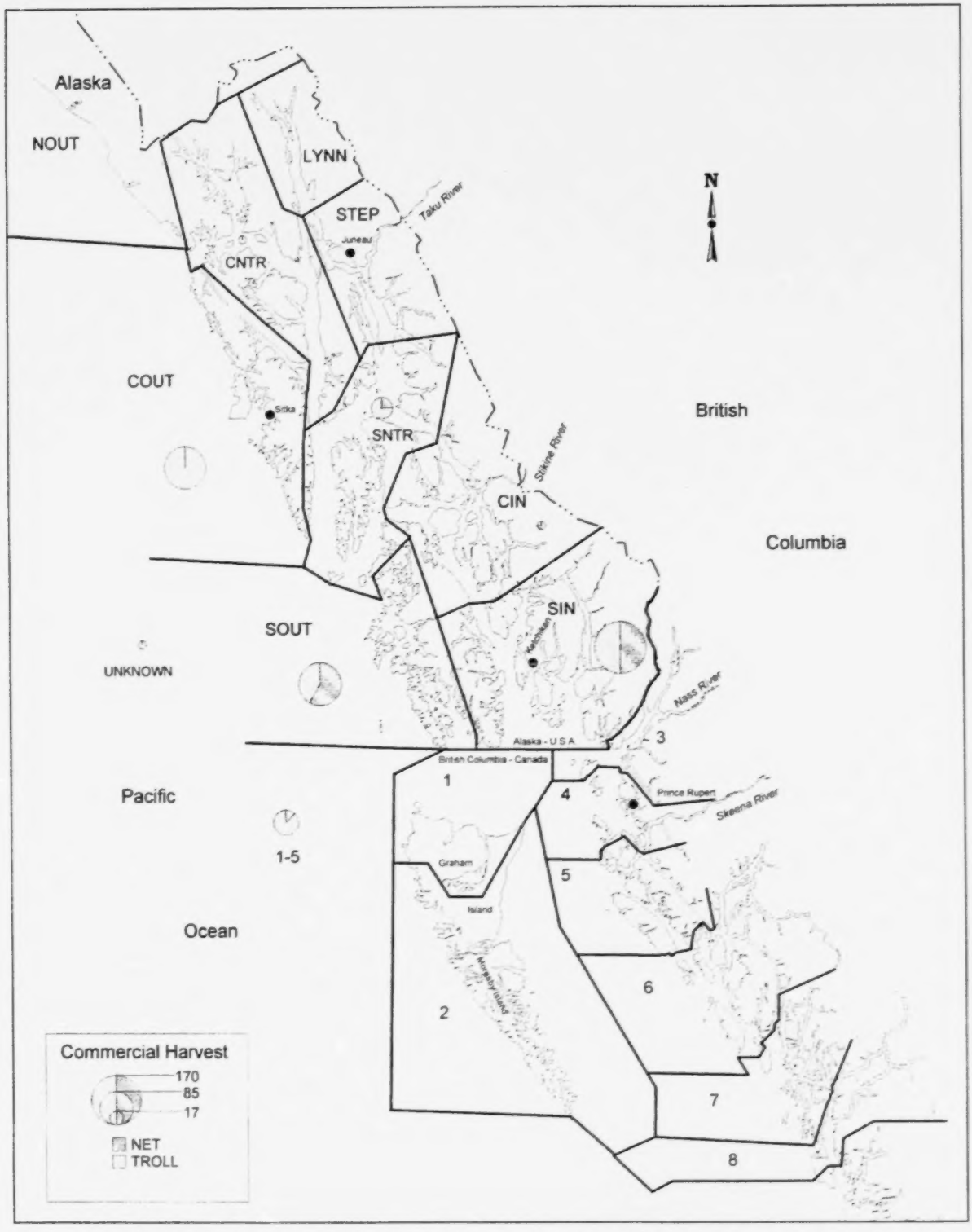

Figure 8. Fisheries Statistical Areas for the north coast of British Columbia and southeast Alaska, and commerical harvest distribution of Zolzap Creek CWT coho, 2003.

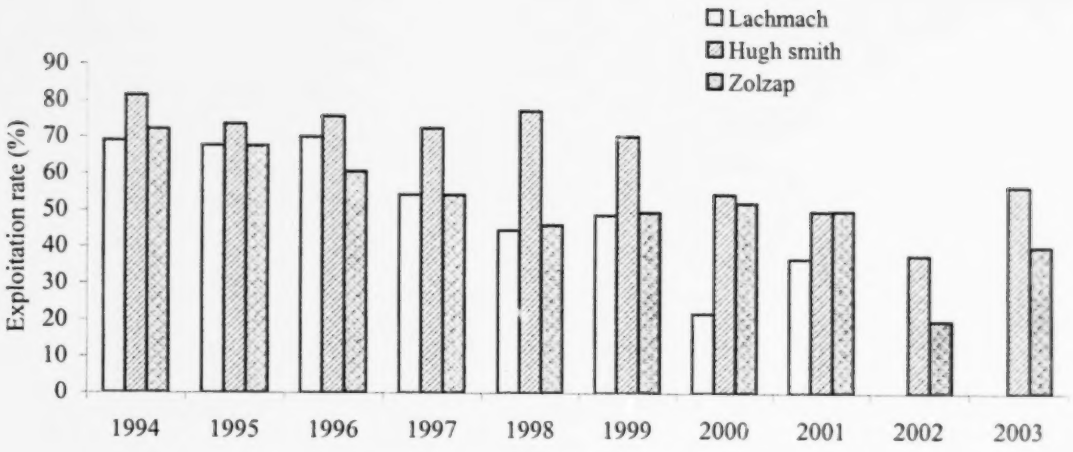

Figure 9. Exploitation rates for three wild coho indicator stocks.

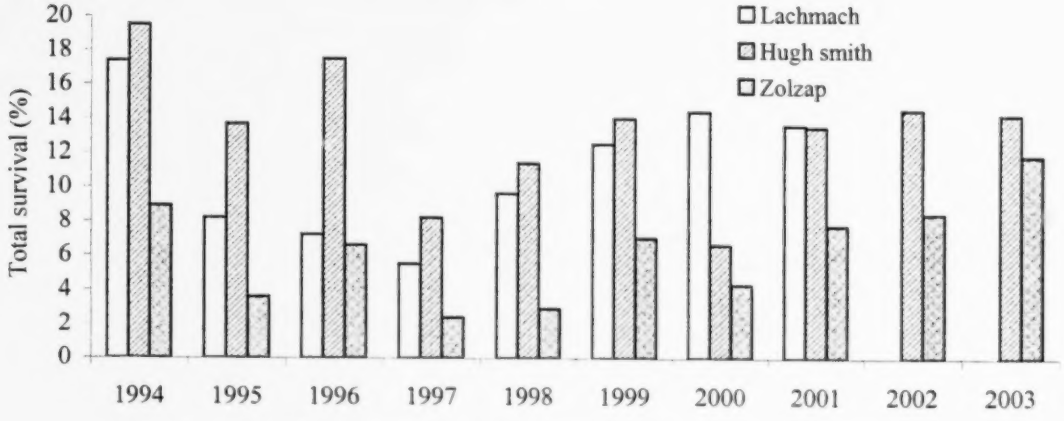

Figure 10. Total percent survivals for three wild coho indicator stocks.

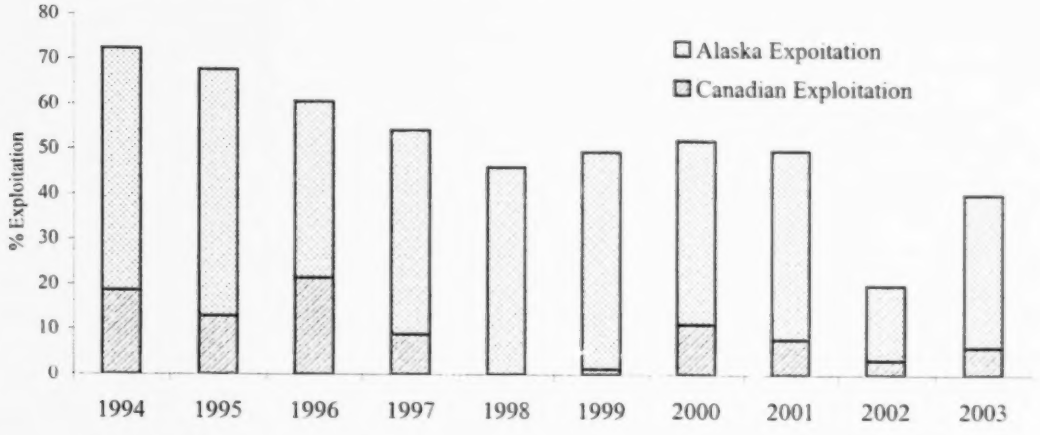

Figure 11. Canadian and Alaskan expoitation rates on Zolzap Creek coho, 1994-2003.

APPENDIX A

Water level and temperature data for Zolzap Creek, 2003

Table A-1. Daily water level and temperature at the spring juvenile and fall adult fences at Zolzap Creek, 2003.

Spring			Fall			Fall		
Date	Gauge Height (m)	Water temp (°C)	Date	Gauge Height (m)	Water temp (°C)	Date	Gauge Height (m)	Water temp (°C)
30-Apr	0.3	8.0	24-Aug	0.2	10.0	07-Oct	0.3	8.0
01-May	0.3		25-Aug	0.2	10.0	08-Oct	0.3	8.0
02-May	0.3	8.0	26-Aug	0.2	10.0	09-Oct	0.3	8.0
03-May	0.3	8.0	27-Aug	0.2	10.0	10-Oct	0.3	8.0
04-May	0.3	8.0	28-Aug	0.2	10.0	11-Oct	0.3	8.0
05-May	0.2	8.0	29-Aug	0.2	10.0	12-Oct	0.3	8.0
06-May	0.2	8.0	30-Aug	0.2	10.0	13-Oct	0.3	8.0
07-May	0.2	8.0	31-Aug	0.2	10.0	14-Oct	0.3	8.0
08-May	0.2	8.0	01-Sep	0.2	10.0	15-Oct	0.3	6.0
09-May	0.2	8.0	02-Sep	0.2	10.0	16-Oct	0.3	6.0
10-May	0.2	8.0	03-Sep	0.2	10.0	17-Oct	0.3	6.0
11-May	0.2	8.0	04-Sep	0.2	10.0	18-Oct	0.3	6.0
12-May	0.3	8.0	05-Sep	0.2	10.0	19-Oct	0.3	6.0
13-May	0.3	8.0	06-Sep	0.3	10.0	20-Oct	0.3	6.0
14-May	0.3	8.0	07-Sep	0.3	10.0	21-Oct	0.2	6.0
15-May	0.2	8.0	08-Sep	0.3	10.0	22-Oct	0.3	6.0
16-May	0.3	8.0	09-Sep	0.3	10.0	23-Oct	0.3	6.0
17-May	0.3	8.0	10-Sep	0.3	10.0	24-Oct		7.0
18-May	0.3	8.0	11-Sep	0.5	10.0	25-Oct	0.7	7.0
19-May	0.2	8.0	12-Sep	0.4	10.0	26-Oct		
20-May	0.3	8.0	13-Sep	0.4	10.0			
21-May	0.3	8.0	14-Sep	0.5	10.0	Mean	0.3	8.5
22-May	0.3	9.0	15-Sep	0.4	10.0	Min	0.2	6.0
23-May	0.3	9.0	16-Sep	0.4	10.0	Max	0.7	10.0
24-May	0.4	9.0	17-Sep	0.3	10.0	Std Dev	0.1	1.4
25-May	1.3	9.0	18-Sep	0.4	8.0			
26-May	1.2	9.0	19-Sep	0.5	8.0			
27-May	1.0	9.0	20-Sep	0.4	8.0			
28-May	0.5	9.0	21-Sep	0.4	8.0			
29-May	0.6	9.0	22-Sep	0.4	8.0			
30-May	0.7		23-Sep	0.4	8.0			
31-May	0.7	9.0	24-Sep	0.4	8.0			
01-Jun	0.9	9.0	25-Sep	0.7	8.0			
02-Jun	0.9	9.0	26-Sep	0.5	8.0			
03-Jun	0.5	9.0	27-Sep	0.5	10.0			
04-Jun	0.5	9.0	28-Sep	0.4	8.0			
05-Jun	0.4	10.0	29-Sep	0.4	10.0			
06-Jun	0.7	10.0	30-Sep	0.4	8.0			
			01-Oct	0.4	8.0			
Mean	0.4	8.5	02-Oct	0.4	8.0			
Min	0.2	8.0	03-Oct	0.4	8.0			
Max	1.3	10.0	04-Oct	0.3	8.0			
Std Dev	0.3	0.6	05-Oct	0.3	8.0			
			06-Oct	0.3				

APPENDIX B

Daily catch at the Zolzap Creek spring juvenile fence, 2003

Table B-1. Juvenile coho catch at Zolzap Creek enumeration fence, 2003.

Date	fry/presmolts	smolts	morts
30-Apr	14	143	0
01-May	22	271	0
02-May	17	108	0
03-May	9	222	0
04-May	9	503	0
05-May	6	190	0
06-May	9	273	0
07-May	10	258	0
08-May	8	182	1
09-May	9	108	1
10-May	9	161	0
11-May	14	263	0
12-May	1	485	0
13-May	3	309	0
14-May	7	638	0
15-May	1	1,390	0
16-May	2	1,694	0
17-May	2	1,040	1
18-May	5	1,069	0
19-May	9	826	0
20-May	1	1,026	0
21-May	2	816	0
22-May	6	870	1
23-May	26	2,209	0
24-May	2	1,932	0
25-May	5	526	0
26-May	8	762	0
27-May	41	1,334	2
28-May	48	2,691	3
29-May	26	1,509	3
30-May	13	849	0
31-May	22	943	0
01-Jun	7	322	0
02-Jun	22	1,145	0
03-Jun	8	685	0
04-Jun	17	886	0
05-Jun	14	1,229	0
06-Jun	11	138	0
Total	445	30,005	12

Table B-2. Non-coho catch at Zolzap Creek enumeration fence, 2003.

	Steelhead		Cutthroat		D. Varden		Sockeye	Chum			
Date	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Juvenile	Cottid	Lamprey	Stickleback
30-Apr	0	0	1	1	18	0	3	0	1	8	2
01-May	0	0	6	6	37	0	4	0	0	21	1
02-May	0	0	1	0	2	0	3	0	0	6	0
03-May	0	0	3	0	19	0	1	0	0	3	1
04-May	0	0	1	0	19	0	3	0	0	5	0
05-May	0	0	1	0	15	0	0	0	1	4	1
06-May	0	0	0	0	29	0	1	0	1	7	0
07-May	2	0	7	6	19	2	0	0	3	22	0
08-May	0	0	6	1	20	0	5	0	3	22	0
09-May	0	0	1	0	30	0	4	0	2	15	2
10-May	0	0	3	0	32	1	3	0	4	14	2
11-May	0	0	12	0	43	0	3	0	1	22	0
12-May	0	0	8	0	52	0	0	0	1	12	0
13-May	0	0	0	0	27	0	5	0	1	17	2
14-May	0	0	1	0	14	0	5	0	4	14	0
15-May	0	0	2	0	30	0	5	0	0	10	1
16-May	0	0	2	0	26	0	1	0	3	15	0
17-May	0	0	1	0	35	0	3	0	1	30	1
18-May	0	0	2	0	28	1	10	0	1	29	1
19-May	0	0	2	4	32	1	7	0	2	32	0
20-May	0	0	2	0	29	0	10	0	3	29	0
21-May	0	0	6	1	50	0	11	0	3	33	0
22-May	0	0	8	0	16	0	16	0	2	32	0
23-May	1	0	7	0	37	0	4	0	1	24	0
24-May	0	0	0	0	34	0	28	0	0	17	2
25-May	0	0	0	0	1	0	2	0	0	1	0
26-May	0	0	1	0	2	0	3	0	0	0	0
27-May	0	0	0	0	6	0	20	0	0	0	1
28-May	1	0	6	1	6	0	2	0	0	0	0
29-May	0	0	0	0	6	0	4	0	1	4	2
30-May	0	0	0	0	3	0	0	0	0	1	0
31-May	0	0	0	0	0	0	1	0	0	1	0

Table B-2. Non-coho catch at Zolzap Creek enumeration fence, 2003.

	Steelhead		Cutthroat		D. Varden		Sockeye	Chum			
Date	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Juvenile	Cottid	Lamprey	Stickleback
01-Jun	0	0	0	0	0	0	0	0	0	0	0
02-Jun	0	0	0	0	5	0	0	0	0	0	0
03-Jun	0	0	0	0	6	0	2	0	0	4	0
04-Jun	0	0	6	0	4	0	2	0	0	18	0
05-Jun	0	0	3	0	3	0	2	0	0	4	0
06-Jun	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	99	20	735	5	173	0	39	476	19

APPENDIX C

Coded-wire tagging data for Zolzap Creek, 2003

Table C-1. Coded-wire tagging data for coho smolts at Zolzap Creek, 2003.

Date	Total smolts	Fence morts	Tag code	No. AFC	Tag morts	No. rlsd. untagged	No. rlsd. AFC
30-Apr	143	0	-	0	0	1	0
01-May	271	0	28-01-08	410	7	2	403
02-May	108	0	-	0	0	0	0
03-May	222	0	28-01-08	330	9	0	321
04-May	503	0	28-01-08	501	3	2	498
05-May	190	0	-	0	0	0	0
06-May	273	1	28-01-08	456	3	6	453
07-May	258	0	28-01-08	254	6	4	248
08-May	182	0	28-01-08	182	1	0	181
09-May	108	0	-	0	0	0	0
10-May	161	0	28-01-08	268	3	1	265
11-May	263	0	28-01-08	262	4	1	258
12-May	485	0	28-01-08	482	1	2	481
13-May	309	0	-	0	0	0	0
14-May	638	2	28-01-08	938	13	7	925
15-May	1,390	1	28-01-08	1,388	6	0	1,382
16-May	1,694	0	28-01-08	1,694	3	0	1,691
17-May	1,040	0	28-01-08	1,036	10	4	1,026
18-May	1,069	0	28-01-08	1,059	14	9	1,045
19-May	826	0	28-01-08	695	7	11	688
20-May	1,026	2	28-01-09	1,121	2	20	1,119
21-May	816	0	28-01-09	813	7	3	806
22-May	870	0	28-01-09	869	5	1	894
23-May	2,209	0	28-01-09	2,194	14	13	2,180
24-May	1,932	3	28-01-09	1,912	6	13	1,906
25-May	526	0	-	0	0	0	0
26-May	762	0	28-01-09	1,286	3	2	1,283
27-May	1,334	4	28-01-09	1,322	2	8	1,320
28-May	2,691	14	28-01-09	415	2	2,258	413
29-May	1,509	4	28-01-12	1,454	8	43	1,446
30-May	849	0	28-01-12	827	1	22	826
31-May	943	0	-	0	0	0	0
01-Jun	322	0	28-01-12	1,242	3	23	1,239
02-Jun	1,145	0	-	0	0	0	0
03-Jun	685	9	28-01-12	1,796	5	22	1,791
04-Jun	886	4	28-01-12	864	7	16	851
05-Jun	1,229	2	28-01-12	1,192	5	30	1,192
06-Jun	138	0	-	0	0	138	0
Total	30,005	46	-	27,262	160	2,662	27,131

APPENDIX D

Daily counts at adult coho at Zolzap Creek, 2003

Table D-1. Daily counts of adult coho at Zolzap Creek enumeration fence, 2003.

Date	No. examined	No. operculum tagged
06-Sep	2	2
07-Sep	0	0
08-Sep	0	0
09-Sep	0	0
10-Sep	0	0
11-Sep	3	3
12-Sep	0	0
13-Sep	0	0
14-Sep	0	0
15-Sep	0	0
16-Sep	0	0
17-Sep	0	0
18-Sep	0	0
19-Sep	0	0
20-Sep	0	0
21-Sep	0	0
22-Sep	0	0
23-Sep	0	0
24-Sep	0	0
25-Sep	415	415
26-Sep	405	405
27-Sep	48	48
28-Sep	21	20
29-Sep	33	33
30-Sep	26	26
01-Oct	8	8
02-Oct	3	3
03-Oct	7	7
04-Oct	0	0
05-Oct	0	0
06-Oct	0	0
07-Oct	7	7
08-Oct	0	0
09-Oct	1	1
10-Oct	0	0
11-Oct	0	0
12-Oct	0	0
13-Oct	0	0
14-Oct	0	0
15-Oct	0	0
16-Oct	0	0
17-Oct	0	0
18-Oct	0	0
19-Oct	0	0
20-Oct	0	0
21-Oct	1	1
22-Oct	0	0
23-Oct	29	29
24-Oct	1	1
25-Oct	434	429
Totals	1,444	1,438